

# ***Chip-scale* Photonics**



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**Microsystems Technology Symposium**

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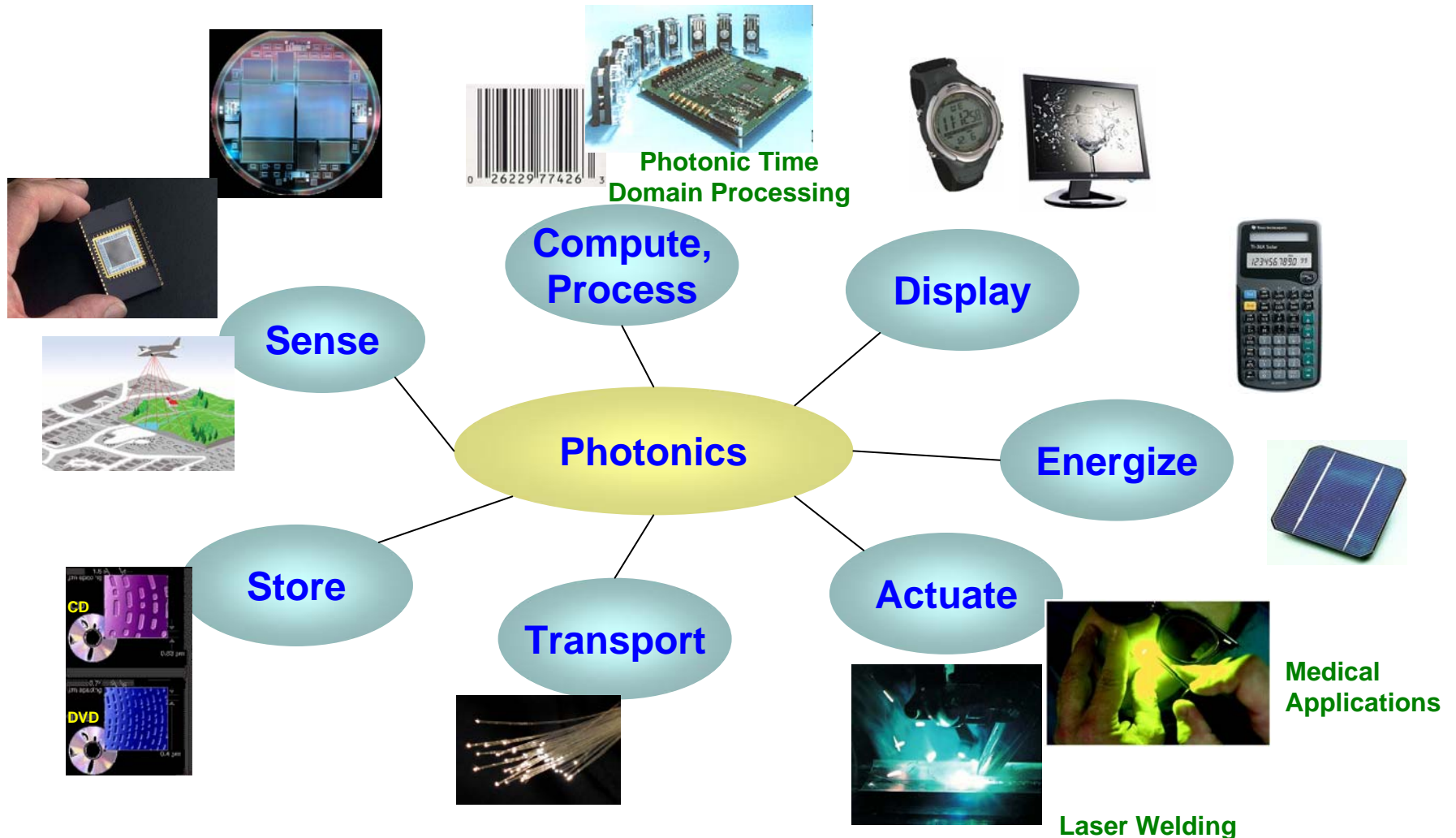
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# Photonic information/energy processing



## What do we do now with photons?





# Photonics at the Chip level



**Many functions require complex circuits structures that may benefit from *chip-scale* fabrication techniques.**

- **Exploit benefits of precise material growth techniques**
- **Achieve maximum performance, yield, and circuit complexity**
- **Combine multiple functions on single chip**
- **Provide means to “get close” to Silicon**
- **Leverage advantages of lithographic design and fabrication for SCALABILITY in future generations**

**But ....**

- **Make sure advantages are real**
  - **Use solid metrics to connect technology and system parameters**
- **Compete with, or “help,” Silicon with great trepidation!**

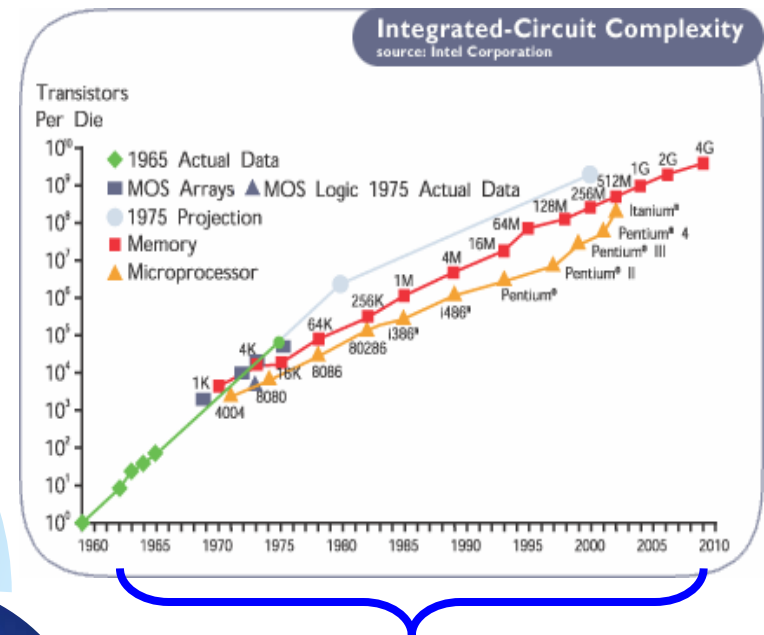
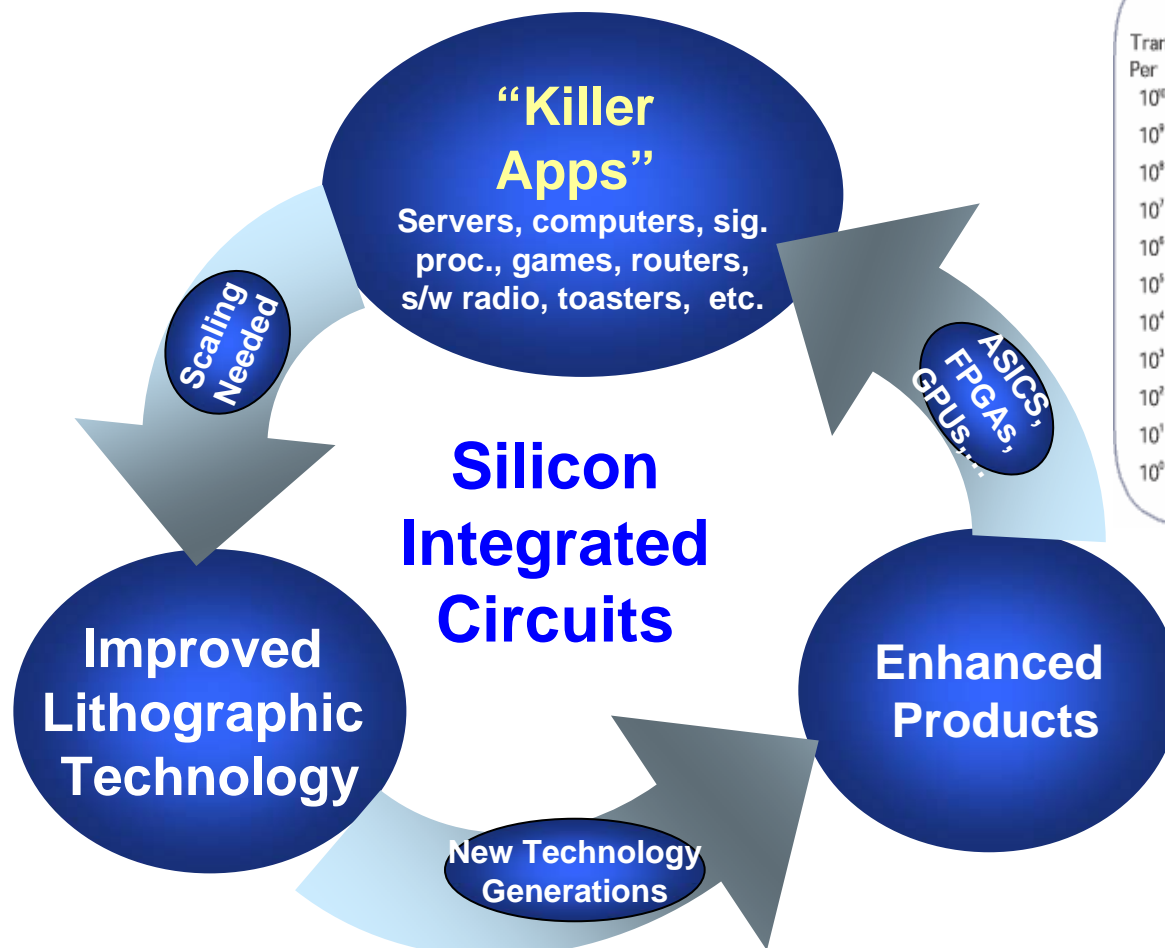


# The vicious (but lucrative) cycle of Si scaling



## Lithography opened path to Scaling:

- Sustained value-added cycle due to IP that is magnified by use of technology platform







## Photonics' "tentative" start at chip-scale scaling ....





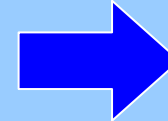
# Litographic Scaling in Photonics



Intellectual Property  
(Circuit Design)



Scaling



Drives  
Technology

So....Will Photonics have an IC-driven scaling pathway?

- Can we leverage the telecom investment and focus on chip-scale applications to drive technology?
- Which Integrated Photonics platforms will emerge?
- How close to the photonic “information density” limits can we get?

AND... Can we go...

**BACK  
TO THE  
FUTURE**

???

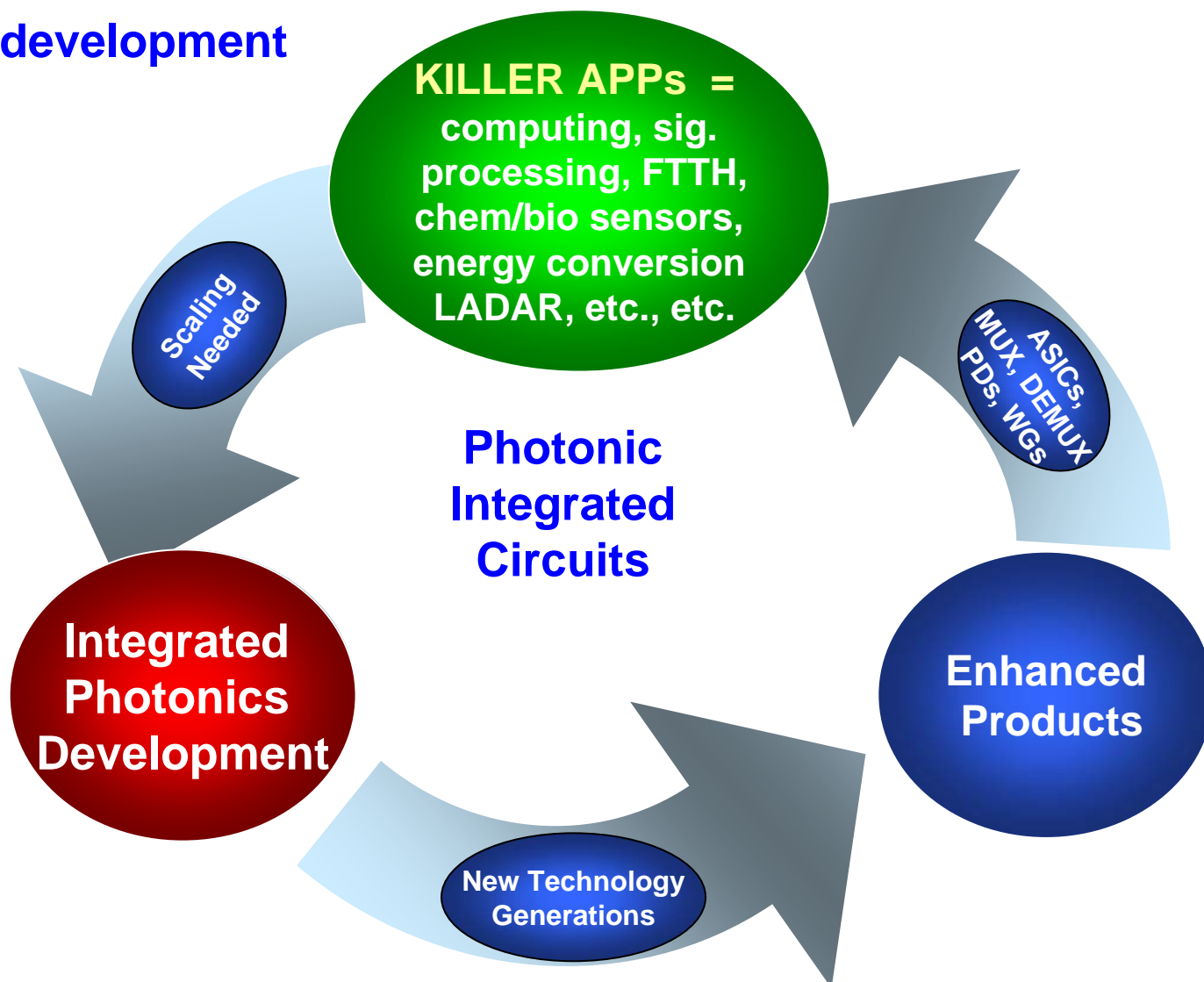
- Analog optical signal processing – that is **scalable** and **programmable**.
- Optical interconnects – to **enable** Silicon scaling
- Optical digital computing – as **complement** to Silicon
- Computational Sensing – but with **integrated flat form-factor** optics.



# Approach: Enrich the “Killer App” domain



... to spur PIC development





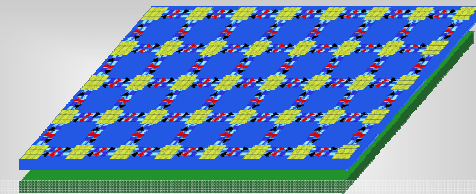


# Photonics Value Proposition

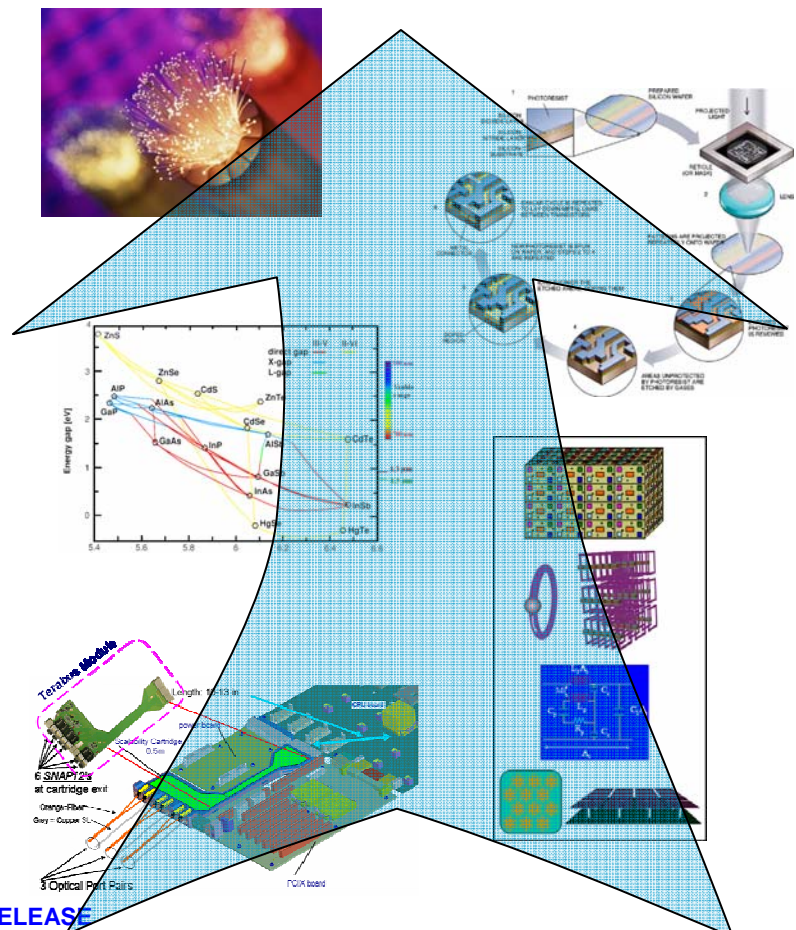


## How do we get there?

- Leverage **3 decades+** of FO technology and related devices (e.g. non-linear optics), but for non-transport functions
- Leverage **4 decades+** of lithography-based chip technology
  - What are the PIC technology platforms?
- Expand **5 decades+** of band-gap engineering
- Employ “Magic Meta-Materials” based on photonic/ phononic/ electronic/ plasmonic engineered materials
- Exploit a PIC’s natural match at interface to outside (photonic) world



## Photonic Integrated Circuits





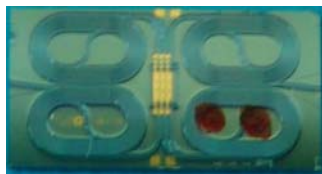
# PICs enable the future



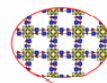
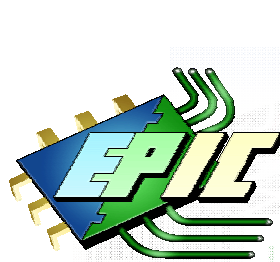
μ-LADAR



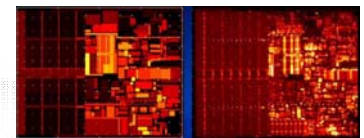
Montage



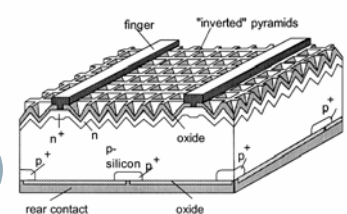
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Optical Buffer



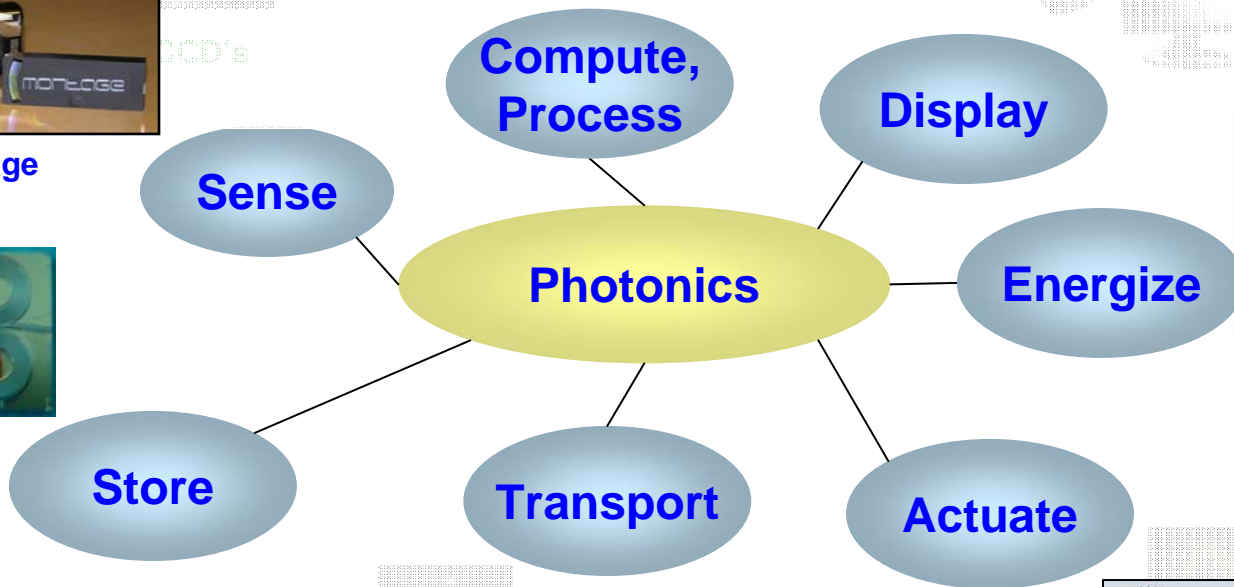
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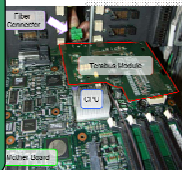
Chip-scale Energy  
scavenging?



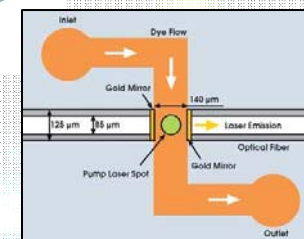
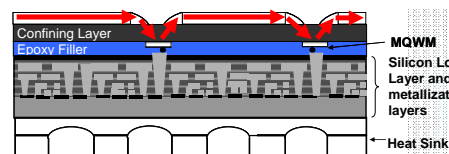
Chip scale solar cell



C201



Intra-chip OI



μ-opto-fluidics

Holographic Storage

Laser Welding



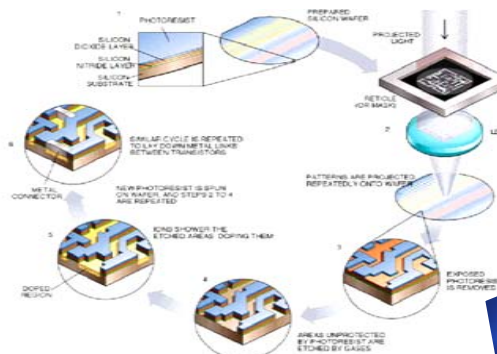
# The PIC Payoff



Old: “finger-fab”  
Photonics



New: “foundry-fab”  
Photonics



Many Killer  
Applications

Fab-less PIC  
design

Technology  
Scaling

